

Zero Retries 0247 - 2026-04-17

2026-04-17 - VARA FM is Not an “Encrypted” Mode and is Legitimate and Legal for Use on Amateur Radio, More Widespread Use of OFDM in Amateur Radio VHF / UHF Data Communications is Imminent, WSJT-X 3.0

Steve Stroh N8GNJ

Zero Retries is an independent newsletter promoting technological innovation in and adjacent to Amateur Radio, and Amateur Radio as (literally) a license to experiment with and learn about radio technology. Radios are computers - with antennas! Now in its fifth year of publication, with 3500+ subscribers.

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Substack says this issue is **too big for email clients**. Thus, it might be easier to read in a web browser: <https://www.zeroretries.org/p/zero-retries-0247>.

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I-Frame

By Steve Stroh N8GNJ

Brief notes about this issue of Zero Retries.

Paid Subscribers / Founding Members Update

My thanks to **Prefers to Remain Anonymous 25** for *renewing* as an **Annual Paid Subscriber** (3rd year! to Zero Retries this past week!

Financial support from Zero Retries readers is a significant vote of support for the continued publication of Zero Retries.

Please direct comments / feedback about **I-Frame** to the [Zero Retries email list with the #ZR0247 hashtag](#).

VARA FM is Not an “Encrypted” Mode and is Legitimate and Legal for Use on Amateur Radio

I discuss the significant accomplishment of developing an independent work-alike implementation of VARA FM in the following article.

Billy Penley KN4MKB’s article on his blog **TheModernHam** - [Reverse Engineering VARA FM Part 1 – Connection Request, Legal Disclaimer and Reasoning](#) makes a number of claims against the popular VARA FM data communications mode used on Amateur Radio VHF / UHF bands. Of course, every individual, and every Amateur Radio Operator, is entitled to express their opinion.

The overall tone of the first few paragraphs of KN4MKB’s article calls into question the “legitimacy” of being able to use VARA FM on Amateur Radio because the information VARA FM’s author has chosen to disclose is not sufficient to create an independent implementation (workalike / interoperable) application of VARA FM for the purpose of passively monitoring VARA FM transmissions.

I disagree with KN4MKB’s assertions that there was not “sufficient” information about VARA FM publicly disclosed by VARA FM’s author.

KN4MKB:

Thousands of amateur radio operators across the United States are using VARA FM, and VARA HF. This issue is that in the United States is that we also have an FCC regulation (FCC Part 97.309(a)(4))

An amateur station transmitting a RTTY or data emission using a digital code specified in this paragraph may use any technique whose technical characteristics have been documented publicly, such as CLOVER, G-TOR, or PacTOR, for the purpose of facilitating communications.

...

At what point between an undocumented frame structure, then XORing the frame bits, 2 different levels of encoding using data tables not viewable from disk(must be dumped from VARA as it is running), and then RNG based constellation mapping that can only be done when you seed the callsigns into a reverse engineered VB6 RNG algorithm do we say this isn’t publicly documented? You are going to keep using something like this, and shake your fist when someone says the word encryption? **There is a reason nobody out there up until now has created a decoder for VARA data frames, and it’s not due to lack of trying.** The details of this encoding/decoding is not documented anywhere. To me, there’s virtually no difference between that, and encryption itself.

KN4MKB’s assertions are only that - assertions / his interpretation / his personal opinions.

I posit that a *reading of the exact wording of* [§ 97.309 RTTY and data emission codes](#) negates KN4MKB’s assertions about VARA FM:

... may use any technique...

... technical characteristics...

... documented publicly...

By the metric of the *exact wording*...

- VARA FM's author has used a technique...
- With various technical characteristics...
- That has been documented, publicly.

Whether a particular “data emission code” in use in (US) Amateur Radio is compliant with “documented, publicly”, *rests solely with the FCC*. Note that in 97.309 (b), if a “data emission code” is not sufficiently “documented, publicly”, there is a specific remedy:

When deemed necessary by a Regional Director to assure compliance with the FCC Rules, a station must:

- (1) Cease the transmission using the unspecified digital code;
- (2) Restrict transmissions of any digital code to the extent instructed;
- (3) Maintain a record, convertible to the original information, of all digital communications transmitted.

§ 97.309 does not offer any specifics as to the degree of detail what must be documented, publicly to use a new “data emission code”.

§ 97.309 also does not offer any specifics about “publicly”. In the 2020s, it’s reasonable to consider “publicly” to be posted on a publicly accessible website. But in earlier eras, prior to the widespread availability of Internet access, “publicly” often meant publication in a magazine. Thus this flexibility of “documented” being not specifically defined, and “publicly” not being specifically defined is, in my opinion, a net positive to Amateur Radio.

§ 97.309 is an Amateur Radio Superpower

I posit that being able to develop and use new “data emission codes” in Amateur Radio with the simple requirement to have (some) “documentation”, disclosed in some “public” manner, is *effectively an Amateur Radio superpower*.

Unlike other radio services that can make use of only those modes, modulations, systems, etc. that are specifically permitted in FCC regulations, Amateur Radio is unique that it can create new modes, modulations, systems, etc.

In the 2020s, this flexibility is going to become highly relevant in Amateur Radio as we begin to see the use of new modes, modulations, systems, etc. that are developed in whole or in part with the use of Artificial Intelligence / Machine Learning. That’s because we humans won’t necessarily know how the AI developed such systems. Especially those of us who aren’t experts in developing new modes, modulations, systems, etc. But there are lots of us who have “ideas” that we’d like to experiment with, and asking an AI to develop such ideas is no different than working with a capable human to develop such systems. What we will be able to “document, publicly” is what AI (especially which version) was used, and what the prompt(s) were to guide the AI to develop the new mode. With the flexibility of “documented, publicly”, Amateur Radio is able to experiment, per...

§ 97.1 Basis and purpose.

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

...

b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art.

...

KN4MKB's Assertions Are a Slippery Slope

If KN4MKB's assertions about VARA FM not disclosing sufficient technical detail, what does that say about the use of a number of popular modes, modulations, systems, etc. that also have not disclosed "sufficient technical detail", such as:

- Digital voice systems whose core technology is the use of the patented, proprietary, technology-not-publicly-disclosed AMBE vocoder? The AMBE vocoder is used in DMR, D-Star, System Fusion, P25, and other systems in wide use in Amateur Radio.
- Pactor 4 is widely used in Amateur Radio for HF Winlink. It's reliable and robust and provides high (for HF) data transfer rates. But the details of Pactor 4 are also proprietary, technology-not-publicly-disclosed.
- LoRa is becoming widely used in Amateur Radio because it provides a robust, modulation that works amazingly well at low power levels and achieves surprising range at those low power levels. Generically, it is an implementation of Chirp Spread Spectrum (CSS), but the specific technical detail of LoRa is, again, proprietary, technology-not-publicly-disclosed.

Another instructive example of this slippery slope about asserting "not sufficient technical detail" disclosed is that the CLOVER mode, *which specifically named in FCC Part § 97.309* has never had "sufficient technical detail" provided. I queried Claude AI for a (simplistic, potentially flawed) reality check:

Are there any "open" implementations of the CLOVER modulation technique for use on HF radio bands? Or, are the technical details of CLOVER considered proprietary, not disclosed publicly?

Claude AI's response:

CLOVER is largely proprietary and closed, which has significantly limited its adoption and longevity. Here's the situation:

What CLOVER is

CLOVER was developed by HAL Communications in the early 1990s (Bill Watkins, W5IYV, was the primary inventor)¹. It uses a multi-tone PSK/AM hybrid modulation with adaptive rate control — quite sophisticated for its era. HAL sold dedicated hardware modems (the P-38, DSP-4100, etc.).

Proprietary status

The core CLOVER waveform and protocol details were never fully publicly documented in a way that enabled independent implementation. HAL held patents on the technique, and the technical specifications weren't released as an open standard. This is in stark contrast to, say, PACTOR (where at least the lower modes had some documentation) or the various open modes like VARA, JS8, Winlink/ARDOP, etc.

Open implementations

As far as is publicly known: no open-source implementation of CLOVER exists. There have been no successful clean-room implementations that gained traction. The combination of patent protection (now likely expired, given the age) and lack of published specs meant nobody built one during the window when it was commercially relevant — and by the time patents would have expired, the mode had been eclipsed by newer digital modes.

Current status

HAL Communications appears to have ceased active development and sales of CLOVER hardware. The mode is essentially dead in practice. Most operators who cared about robust HF digital moved to PACTOR III/IV, or more recently to VARA HF (which is semi-open/free but not fully open-source either).

...

If you're researching this for historical coverage, the ARRL's QEX magazine had some early 1990s articles on CLOVER that are probably the most detailed public technical documentation available.

And... here we're presented with a continuation of the slippery slope about what constitutes "disclosed, publicly". While ARRL provides a reference page for CLOVER² with some technical detail: <https://www.arrl.org/clover>, the technical detail that might be sufficient to be able to create an independent implementation of CLOVER is largely in the References articles. Some of the publications listed aren't accessible at all - CQ Communications is out of business, and access to its magazines are in legal limbo. Does having published once in a magazine (that you can no longer access) count as "disclosed, publicly"? Past issues of QEX are only available to current (paid) members of ARRL. Does access to those issues of QEX by (paid) ARRL members, but not available to those who are not ARRL members count as "disclosed, publicly"?

Over time, Amateur Radio (and the radio technology industry in general) has developed "understanding" of how all of the above "work"... but that's not the same as having all the technical details publicly disclosed for the purposes of developing independent workalike, interoperable systems to be able to monitor transmissions from these systems.

Want to Monitor? Just Buy a System.

But for anyone that wishes to do so, the simple expedient of buying a compatible system...

- a DMR, D-Star, System Fusion, P25 radio that incorporates an AMBE vocoder,
- a Pactor 4 modem,
- a unit that incorporates a LoRa radio,
- VARA FM and VARA HF software can be downloaded at no cost³.

provides a *reasonable* ability to monitor the usage of such systems on Amateur Radio spectrum. Including, if one is really motivated to monitor CLOVER transmissions, going to some trouble, of finding a used HAL Communications P-38 or DSP-4100 on eBay.

Conclusion

In the above, I am not positing that the author of VARA FM has disclosed a lot of technical details about VARA FM sufficient to allow other compatible, interoperable implementations to be created. That is not the case.

I am also not positing that the author of VARA FM didn't make a number of technical choices in their implementation of VARA FM that are unexplained.

I conclude that that the author of VARA FM has met the *letter of FCC § 97.309*:

... technical characteristics have been documented publicly, ...

because at least *some* technical characteristics *have* been documented publicly.

That is all that is required.

An individual Amateur Radio Operator's opinion (whatever their background) of whether a particular system's "technical characteristics have been documented publicly" adequately, or not adequately, are irrelevant. *That* is solely the FCC's determination.

I further posit that this ambiguity provides a huge advantage to Amateur Radio.

The simple expedient of:

... technical characteristics have been documented publicly, ...

allows the development of any new technology, system, modulation, etc. to be used on Amateur Radio spectrum.

Lastly, I offer this a straw man argument... imagine what the FCC would do if it wants to monitor a transmission from an Amateur Radio repeater that uses P25 technology.

Is the FCC going to attempt to create its own independent implementation of a P25 receive capability from "... technical characteristics have been documented publicly...?"

Or is it just going to resort to the simpler, more practical expedient of purchasing a P25 radio and begin monitoring?

Please direct comments / feedback about this article to the [Zero Retries email list with the #ZR0247 hashtag](#).

More Widespread Use of OFDM in Amateur Radio VHF / UHF Data Communications is Imminent

By Steve Stroh N8GNJ

Behind the scenes of some popular Amateur Radio modes, OFDM has been quietly emerging as a significant improvement in data communications in Amateur Radio. I predict that in 2026, OFDM will come out from behind the scenes to be more widely used (and recognized). OFDM will create new capabilities... and more capable data modes.

The first (that I'm aware of) and most widely known implementation of "Audio band Orthogonal Frequency Division Multiplexing (OFDM)"⁴ in Amateur Radio data communications, is VARA FM. With the use of "Audio OFDM", VARA FM is robust, adaptable to varying conditions on the radio channel, and provides greater data rates than other technologies used on Amateur Radio such as Frequency Shift Keying (FSK).

Very tersely, OFDM divides a communications channel (either an audio channel, or a radio channel) into many subcarriers, and then operates each subcarrier as if it is an independent audio, or radio

channel - boosting power for subcarriers that need it, “striping” data across multiple subcarriers with redundancy.

Various Implementations of OFDM in Amateur Radio

As far as I can (*very inexpertly*) determine, there was nothing unique about the way OFDM was applied in VARA FM. Thus it was possible for others to create audio band, or radio channel modes that incorporated OFDM. For example, the following modes also use OFDM techniques in dividing a channel into subcarriers:

- [MT63](#) text message / data mode
- [FreeDV](#) digital voice mode
- [Ribbit](#) text message mode
- [Mercury](#) data mode
- [Hush](#) data mode (*added post publication*)

VARA FM implements a number of other techniques besides OFDM to make it so effective as a data mode for VHF / UHF. Examples:

- Channel sounding
- Handshake between two stations to determine maximum common capabilities
- Forward Error Correction (FEC)
- “Upshift / Downshift” of speeds, modulations, etc. for reliability versus throughput

Thus it’s notable that Billy Penley KN4MKB, in an article on his blog **TheModernHam** - [Reverse Engineering VARA FM Part 1 – Connection Request, Legal Disclaimer and Reasoning](#) claims to have created an independent, interoperable equivalent of VARA FM:

At the point of writing, I have a fully functional modem that can complete a basic connection cycle with VARA FM. It can generate its own compatible frames, and decode the ones sent back from VARA FM as well. It lacks the automatic speed change based on SNR at this time.

A basic requirement of creating a independent, interoperable equivalent of VARA FM is to understand all the elements of VARA FM, and KN4MKB has done an admirable job of describing the basic functionality of VARA FM:

A high level overview of the VARA FM Program.

VARA at its core is a digital modem with **Orthogonal Frequency-Division Multiplexing (OFDM)** with adaptive modulation, scaling from 4PSK up through 256QAM to achieve data rates from roughly 550 bps to over 25 kbps. VARA operates as a TCP server, listening on one port known as the “Control Port”, and another port known as the “Data Port” (8300, 8301 by default.) The modem handles all modulation, demodulation, error correction, and ARQ protocol internally.

The application seems to have been written in Visual Basic 6 by Jose Alberto Nieto Ros (EA5HVK).

The basic idea, is that an application (like Winlink Express) can simply connect to VARA port 8300, and setup some basic parameters (Listen callsign, connecting callsign, bandwidth mode etc. The application can start and stop connections by sending special commands to this port. Once

connected, the application can then send data to the data port on 8301, and also read data from it as well. The great part is that the application doesn't really need to know much about how the modem itself works. It just sends the connection request, (Or listens for one), and reacts with data meant for the other side.

KN4MKB goes on, at length to describe the inner workings of VARA FM. I hope that KN4MKB follows through in releasing his system. A system that provides equivalent features to VARA FM that is open source and thus can be ported to operate on Linux (especially on Linux systems such as Raspberry Pi 4 and 5) without the need for the "overhead" of operating VARA FM on a typical Windows system, would be welcome and highly useful.

But beyond the news about KN4MKB's of a "VARA FM equivalent", there's other news about the use of OFDM in Amateur Radio.

NinoTNC Implementation of OFDM

Recall this Press Release from Alberta Digital Radio Communications Society (ADRCs):

Calgary, Alberta, January 30th 2026. The Society is pleased to announce that it is collaborating with the Terrestrial Amateur Radio Packet Network group (TARPN) to implement an audio band version of its OFDM technology in their Terminal Node Controller (TNC). "Adding the TNC rounds out the vision of the supernode that we presented at the Zero Retries Digital Conference last September and extends the functionality of the IP400 network to conventional radios on the 2M, 220 and 450 MHz bands, without any modifications", says Martin Alcock, VE6VH, founder of the IP400 project. "Adding OFDM to our TNC gives us a higher speed mode than previously implemented and practical experience with OFDM", says Nino Carrillo, KK4HEJ, creator of the TNC. Martin goes on to say "in addition it will give us access to proven KISS mode technology that will greatly enhance the utility of our existing nodes in delivering higher data rates for conventional packet radio applications on existing terrestrial networks".

Although ADRCs / IP400 is working with KK4HEJ on "Audio OFDM", their (hardware) implementations are different. IP400 describes their implementation as "[Mode B](#)":

Mode B

Mode B is unique to the IP 400 project, to implement a higher speed data mode that interfaces to conventional radios, by providing a baseband (mic/speaker) connection to the radio. It achieves higher speeds using a technique known as OFDM (Orthogonal Frequency Division Multiplexing), also known to as LTE on the cellular band. This mode can be used with any existing radio or repeater in either the 144, 220, 440 or 902 MHz bands. Existing analog repeaters can be upgraded by adding of a small amount of hardware, and an audio path to existing AllStarLink systems are also supported with a custom audio driver.

The hardware for this mode employs a high end microcontroller and FPGA (Field Programmable Gate Array), all of which are field upgradeable.

(That description, unique to the IP400 project, probably predates the decision to collaborate with KK4HEJ.)

Since then, I haven't seen any (public) status reports from either IP400 or NinoTNC, but there apparently is considerable progress being made on both "sides". But recently, there were some public updates on Discord.

I'm not a user of Discord, so I did not see this discussion for myself, but a number of screenshots were shared with me from the ninotnc Discord channel. The text in the screenshots were transcribed by Claude AI, and lightly edited for publication by me.

John N3XKD — Hey Nino, you don't have any news on the IP400 collab, do you ?

Nino KK4HEJ — Sure do. We have been designing and testing OFDM waveforms that fit in a 3 kHz audio channel, that can be sent and received over an unmodified FM radio through the mic/speaker jacks. The 3kHz audio scheme uses 116 data carriers at about 22.7 symbols per second. Constellation complexities vary from BPSK to QAM256.

John N3XKD — So, What's that translate to in throughput and what hardware-ish?

Nino KK4HEJ — We hope to realize around 18kbits/sec in an audio channel. Lots more in a wideband channel (like an FM radio with a data port). The IP400 project is building a daughter card that slots into the NinoTNC that carries an FPGA and STM32. But... I am getting more confident that I'll be able to implement most of the audio channel capability in the dsPIC.

[scatter plot image — IQ constellation]

This is an actual over-the-air test of a QAM64 OFDM constellation that carries around 14kbits/sec. The transmit audio was fed into the mic port of an FTM-3100 and the receive audio was taken from the headphone jack of an IC-2000H. Processing was done on a computer. SNR in that I/Q plot measured at around 25dB, so almost a full-quieting FM signal.

Nino KK4HEJ — The heavy-hitter magic in this mode are the time-domain synchronization approach and the channel equalization scheme. The modem will be performing real-time channel estimation for each packet, which accounts for emphasis mismatch and timing offset errors.

John N3XKD — So, will there be a requirement for time sync ? frequency and phase ? Would you mind if I shared some of your info with the un-official IP400 discord ?

Nino KK4HEJ — Not in an external sense. The transmitter and receiver will be asynchronous. The decoding modem will be doing hard work to search for the sync preamble from the transmitting modem. Once that sync preamble is found, the decoding modem has a fairly large timing window to do the frequency-domain work.

John N3XKD — Ah ok, kinda like T1 timing, how you could time off of one end or the other

Nino KK4HEJ — I don't mind, this is mostly written into the IP400 spec. I am not the IP400 communication lead, so I'm not sure what they are putting out. There are many modes encompassed in the IP400 project. We were calling this mode OFDM-AB at first (for audio-band), but I think it is called OFDM-B now.

John N3XKD — Yeah, looks like B.

...

John N3XKD — This is going to be essentially a KISS setup right ?

Nino KK4HEJ — There is a KISS mode in the IP400 architecture. The NinoTNC is a KISS device now and it will stay that way in the future. There are other interface methods with their supernode, but that's outside of my scope.

John N3XKD — Yeah, it's tough to follow the A and C modes, but this B mode is extremely interesting (*edited*) It'll benefit TARPEN big time Regular packet, you name it I have a pair of the dev radios and a pair of the Pi Zero hats for the A mode, just haven't done much with them

Nino KK4HEJ — The B mode is what I care about the most, but we are moving so fast on the B mode that one of the other modes will be a high-speed mimic of it. Can't remember if it's A or C. One of those is 4FSK, the other is super-wideband OFDM.

John N3XKD — I 'think' A I think the super wide is the C I think the A is the one that's being targeted to fit into the 70cm rules C is like 900 and up maybe, I 'think'

Nino KK4HEJ — Ya, it's a big project. To their credit, they are very focused on actual radio links. I only have enough capacity to keep focused on the B mode. This is the output of one of my python-based ofdm demodulator programs. The input was a wav file of audio recorded from a radio link. Top left you can see the channel magnitude response, bottom left is the phase response of the channel. The equalizer accounts for both, the red dots in the I/Q charts are the output of the equalizer. The grey dots in the I/Q charts are the unequalized samples. This is an early waveform, we have adjusted since, but demonstrates the capability of the equalizer pretty well.

[multi-panel chart image — channel magnitude, phase, and IQ symbol plots]

Tadd KA2DEW — This is incredible!

(I agree with KA2DEW!)

In addition to all of those implementations of OFDM, there is another promising implementation of OFDM in progress - [Mesh Operations Protocol \(MOP\)](#) in development by Stefaan Desmedt KO6IKR:

MODEM - OFDM modulation (4800 bps) / Direwolf / TCP Ether test

All of this development of OFDM is wonderful and welcome. Amateur Radio data communications on VHF / UHF has been hampered by limiting its interoperability to 1200 bps AFSK, and semi-interoperability of 9600 bps FSK, and widely varying implementations of other speeds, and modulation methods.

Yes, we've had and have...

- 25 kbps with VARA FM (proprietary, uses a wideband audio interface and radio with flat audio input / output)
- 56 kbps with the WA4DSY 56k modem (unique radio + transverter, open source)
- 128 kbps with the Icom DD mode (unique, proprietary mode, Icom radios only)
- 100 kbps - 1 Mbps with New Packet Radio (unique radios, open source)

But we've had frustratingly little that most people could actually use with their existing radios, other than VARA FM. Apparently in 2026, that will change!

Recounting, these are implementations of OFDM for use for Amateur Radio VHF / UHF intended as a data (file exchange) mode available or in development:

- MT63
- Mercury (currently targeted at HF, but not "restricted" to use on HF)

- Hush (*added post publication*)
- VARA FM
- KN4MKB independent implementation of a “VARA FM Workalike”
- IP400 “Mode B” by IP400 on IP400 hardware
- IP400 “Mode B” by Nino Carrillo KK4HEJ for implementation on the NinoTNC
- Mesh Operations Protocol (MOP)

The energy, creativity, and talent that is being applied to the above is exciting and encouraging. But I can foresee a looming... ~~problem~~ *situation* emerging.

Another Amateur Radio Tower of Babel - OFDM?

Of the OFDM implementations mentioned,

- KN4MKB’s project is working to be interoperable with VARA FM.
- IP400 and NinoTNC are working to be interoperable *with each other*.

That’s the extent of attempts at interoperability with these new implementations of OFDM in Amateur Radio.

Thus we might be on the cusp of creating a new [Tower of Babel](#) situation similar to what has occurred with Digital Voice systems used on Amateur Radio VHF / UHF - not interoperable, despite being very similar from a technical perspective.

It would be a shame if that same situation emerged with OFDM implementations in Amateur Radio such as a **NinoTNC operating “Mode B”** not being able to interoperate with a **MOP node**. Similar to the disparate Digital Voice modes, we would have “technical islands” of connectivity that couldn’t interoperate or network via radio.

Given that all of these modes are entirely software-defined, designed to work within the audio bandwidth of a typical Amateur Radio VHF / UHF transceiver, either with microphone / speaker connections or (works better / faster) with flat audio connections, it seems feasible that all of these OFDM implementations could work out interoperability details for the basic modulations. All of the other details about their various modes of operation - protocols, etc. could all be hashed out as “Protocol IDs”.

Yes, it’s going to be possible to “be compatible with any / all modes” with the capabilities of Software Defined Radios such as the LinHT... but there are going to be a lot of existing radios / modems that could be adapted to use these new “Audio OFDM” capabilities. Thus the best-case scenario would be if these Audio OFDM modes could be made interoperable. Or, *at very minimum*, recognize each other’s transmissions and thus sense an existing transmission in progress and avoid “doubling” with each other. This a real issue with 1200 bps AFSK and 9600 FSK packet radio not being able to share a channel because they cannot detect the other mode’s transmissions.

Perhaps, Some Coordination?

Thus, I suggest, again, the possibility of forming an organization modeled on my idea of the [Amateur Radio Standards Organization \(ARSO\)](#). It doesn’t have to be a formal, dedicated organization - it could be an ad-hoc assemblage of interested parties. I hope that such an organization / activity could

be sponsored by an existing “parent” organization. I’ve done some outreach about that possibility... but have not received any encouraging responses.

Or perhaps I’m hopelessly out of date in this approach. Perhaps the necessary technical coordination could be hashed out with the interested parties showing up on the same Discord channel and hash out their respective code on a new Github repository.

I also offer the interested parties involved in the above a forum / presentation slot (panel discussion perhaps?) at [Zero Retries Digital Conference 2026](#).

In any case, whatever the outcomes, 2026 promises to be a very interesting year for Technological Innovation in Amateur Radio.

Please direct comments / feedback about this article to the [Zero Retries email list with the #ZR0247 hashtag](#).

ZR > BEACON

By Steve Stroh N8GNJ

*Short mentions of **Zero Retries Interesting** items.*

[WSJT-X 3.0 Upgrade Is Significant](#)

Tom Salzer KJ7T in Random Wire 178:

Here’s a rundown of what changed from WSJT-X 2.x to 3.0, released April 8, 2026. ([Find WSJT-X on SourceForge](#).) When you upgrade, it’s good practice to back up your WSJT-X.ini and log — your settings should migrate (mine did), but better safe than sorry.

I had listed WSJT 3.0 as an item for inclusion in this issue’s ZR > BEACON, but when I opened Random Wire 178 Friday morning, candidly... *KJ7T did a much better job* of explaining the relevance of this upgrade than I was prepared to do in as a short mention in ZR > BEACON. Just click the headline to go directly to that article on Random Wire 178. Or, treat yourself to the entire issue - [Random Wire 178](#).

Two Good Articles on M17 In Random Wire 178

Not to pile on too deep on Random Wire 178 and the KJ7T Admiration Society, but if you’re a fan of M17 and pressed for time, check out these two articles by KJ7T:

[Notable: Jim N1ADJ’s M17 Go Tools Project](#)

and

[M17 Data Modes: The Sleeping Giant Wakes](#)

I appreciate the excellent job that KJ7T is doing in following developments on M17.

[Ham Radio History: How RTTY Became the First Mainstream Digital Data Mode](#)

Mark Haverstock K8MSH on the On All Bands blog:

Radio Teletype (RTTY) became a popular digital mode in amateur radio through a mix of postwar circumstances, technical curiosity, and a group of operators who looked at a 180-pound machine and thought, “This would look cool in my radio room.” Its growth reflects both the experimental spirit of ham radio and the fact that, sometimes, if it makes noise, prints letters, and connects to a transmitter, hams will find a way to make it communicate with the world.

History of RTTY, Part 1

The origins of RTTY can be traced back to the late 19th and early 20th centuries with the invention of teleprinters, also known as teletypewriters. These machines sent typed text over wires using electrical signals encoded in standardized formats, such as the Baudot code. By the 1920s and 1930s, teleprinters were already well established in wireline communications, particularly for news agencies, government operations, and business.

However, early experiments in transmitting teleprinter signals over radio faced several challenges. Noisy radio frequencies were prone to interference, making reliable transmission of digital signals difficult. But soon, engineers discovered that frequency-shift keying (FSK)—a method where two distinct tones represent binary states—was particularly robust against noise. Instead of transmitting simple on/off signals (as in Morse code), RTTY used two tones to represent “mark” and “space,” corresponding to binary 1s and 0s. This made the system far more reliable over long distances and under poor propagation conditions.

This is a really good summation of the history of RTTY on Amateur Radio. One intermediate stage between the mechanical teletypes and personal computers was when microprocessors became widely available, companies like HAL Communications produced microprocessor-based RTTY modems / Terminal Unit (TU) (encoder, decoder). I remember one unit had the innovation of a parallel printer port that you could connect to a common dot matrix line printer which would then print everything received by the TU.

I’m surprised that K8MSH didn’t mention one of the most popular uses for RTTY - [RTTY Art](#). Using the “nuances” of careful selection of characters, one could transmit images via RTTY. Calendars were popular, and some images were... “racy”.

I’ve found that www.rtty.com is a fantastic resource for all things Amateur Radio RTTY. Whenever I’ve done a web lookup for something relating to Amateur Radio RTTY, I seem to get directed to some corner of that site.

My thanks to [Amateur Radio Weekly, Issue 416](#) for the first mention I saw of this article.

[Stealth Signals Are Bypassing Iran’s Internet Blackout](#)

Evan Alireza Firoozi in IEEE Spectrum:

...

Thirteen days into the January shutdown, we at [NetFreedom Pioneers](#) (NFP) turned to a system we had built for exactly this kind of moment—one that sends files over ordinary satellite TV signals. During the national information vacuum, our technology, called [Toosheh](#), delivered real-time updates into Iran, offering a lifeline to millions starved of trusted information.

...

Satellite TV uses a file system called an [MPEG transport stream](#) that allows multiple audio, video, or data layers to be packaged into a single stream file. When you tune in to a satellite channel and select an audio option or closed captions, you’re accessing data stored in different parts of this

stream. The NFP team's insight was that, by piggybacking on one of these layers, Toosheh could send an MPEG stream that included documents, videos, and more.

...

A satellite receiver can't tell the difference between our data and normal satellite audio and video data since it only "sees" the MPEG streams, not what's encoded on them. This means the data can be downloaded and read, watched, and saved on local devices such as computers, smartphones, or storage devices. What's more, the system is entirely private: No one can detect whether someone has received data through Toosheh; there are no traceable logs of user activity.

...

NFP's solution was to add redundancy, similar in principle to a data-storage technique called RAID (redundant array of independent disks). Instead of sending each piece of data once, we send extra information that allows missing or corrupted packets to be reconstructed. Under normal circumstances, we often use 5 percent of our bandwidth for this redundancy. During periods of active jamming, we increase that to as much as 25 to 30 percent, improving the chances that users can recover complete files despite interference.

This is a fascinating article about this technique of repurposing a bitstream designed for one use case to transfer files. This overall idea, transmitting *bulletin files*⁵ is a technology that has been little-used (that I'm aware of). My favorite implementation of this idea is [flamp - Amateur Multicast Protocol](#). flamp (and an earlier implementation of this idea, RadioMirror) divides a collection of files to be transmitted into blocks. All of the blocks are transmitted sequentially with a sequence number and checksum. The flamp receiver is passive - there's no ARQ (Automatic Retry Request) mechanism. If a block is received with an incorrect checksum, the file isn't reassembled until a block with the correct checksum is received. I think this system could be made even better with the IL2P Forward Error Correction system that's now available as open source. When I finally get a test repeater on the air, this will be one of my use cases for the repeater - transmitting bulletin files, using flamp, in the wee hours.

This system is potentially useful for Amateur Radio because of the idea that is periodically floated about "what if Amateur Radio could obtain the use of a transponder on a geostationary satellite"? This system could be used with no changes in the "video" paradigm of the uplink and satellite infrastructure, unlike the unique uplink and receiver hardware that [Outernet / Othernet system / service](#)⁶ required.

Use of a geostationary (GEO) satellite transponder by Amateur Radio isn't an absurd idea given the increasing irrelevance of the two primary uses of transponders on GEO satellites - broadband Internet access (Starlink has almost entirely killed that business model) and Direct Broadcast Satellite ("cable television via satellite) (also killed by Starlink customers using streaming video). Thus there might be "deals" available for the use of entire transponders or sharing the use of a transponder in the wee hours.

[Fixing Baltimore's Unequal Weather Data Coverage](#)

Rebecca Owen on EOS:

[Vaugh et al.](#) describe a [partnership](#) between universities, state agencies, and Baltimore residents to build the [Baltimore Community Weather Network](#) (BCWN) that addresses the missing data coverage around the city. Unlike the patchwork of personal weather stations, community members participating in the BCWN are from underserved areas in the city and are actively involved in data collection and interpretation.

Weather stations are placed in open spaces to avoid obstacles like buildings or trees affecting measurements of temperature, rainfall, or wind. This careful placement is designed to ensure that the data collected are as close as possible to the conditions experienced by actual residents.

BCWN sites are carefully monitored and managed by community members. Baltimore residents are actively involved in data collection, weather station management, and decisionmaking with scientists and local organizations to help promote engagement, education, and community empowerment.

[Group Seeks to Close RADAR Gap with Hays Community Radar Project](#)

Cristina Janney in Hays Post:

The Hays Community Radar Project is seeking to raise \$360,000 to purchase and install a Furuno dual-polarity Doppler weather radar to cover Hays and the surrounding area.

This initiative aims to eliminate a dangerous blind spot in Kansas weather coverage. Because the nearest National Weather Service radar is in Dodge City, the Earth's natural curvature creates a beam overshoot problem.

The radar beam from Dodge City travels upward as it moves away from the source. By the time it reaches Hays, the bottom of the beam is at about 6,000 to 7,000 feet.

"Because the NWS beam travels in a straight line, it is over 7,000 feet over our heads in Hays," said Dr. Kendall Krug, a board member at STEM Harvest and a member of the local amateur radio club.

"Most severe weather events, like developing tornadoes, microbursts and low-level wind shear, typically occur below 7,000, and can go completely undetected,"

I was not aware that purchasing and operating a weather RADAR was even a possibility on the scale of a small community.

Taken together, these two developments are yet more ways in which that radio technology can be used in community settings and operated by technically interested community members. Like community FM radio stations, "professional quality" weather stations, and now apparently weather RADAR can be financed by small communities, and operated by community members. In my previous career, another example of community technology infrastructure was the construction and operation of Wireless Broadband Internet Access systems using unlicensed spectrum. Such systems are even more feasible using [Citizens Broadband Radio Service \(CBRS\)](#) spectrum and systems. Another community infrastructure system could be one or more GMRS repeaters that are used for Skywarn storm spotting.

While none of these systems use Amateur Radio spectrum (and thus supporters are not required to be licensed), participation of Amateur Radio Operators who have hands-on experience with radio technology would be an invaluable contribution to the effective operation of such systems in small communities.

[FCC Reviews Growing Space Sector's Need For Spectrum](#)

Amateur Radio Newsline Report 2528 for Friday, April 10th, 2026:

STEPHEN/ANCHOR: We begin this week in Washington, D.C. An official posting on the website of the Federal Communications Commission refers to potential new spectrum users as - and this is their terminology - "weird space stuff." Kent Peterson KCØDGY explains what's going on.

KENT: Expecting that orbital laboratories, inhabitable spacecraft, in-space repairs and many other related uses are going to have a need for greater access to the RF spectrum, the Federal Communications Commission is seeking comment on ways to make that happen. The agency voted last month to address new ways to support tracking, telemetry and command for a variety of on-the-horizon initiatives.

The FCC published the proceeding on its website, referring to the uses as [quote] “weird space stuff.” [endquote] The agency said that the proposed rulemaking is part of a larger effort to modernize policies in support of the quickly growing space sector. It encouraged comments in particular from companies involved in different aspects of lunar missions, satellite-servicing or related operations.

One of the potential frequency ranges referenced in the Notice of Proposed Rulemaking is frequency range 2305 MHz to 2315 MHz, which overlaps part of the amateur radio allocation on 13cm. The proposal is Docket Number 26-54.

This is Kent Peterson KCØDGY.

(FCC)

No joke - the formal title of this FCC posting is **Spectrum Abundance for Weird Space Stuff**. [From the PDF](#):

FCC FACT SHEET*

Spectrum Abundance for Weird Space Stuff

Notice of Proposed Rulemaking – SB Docket No. 26-54

Background: In this Notice of Proposed Rulemaking (NPRM), the Federal Communications Commission (Commission) looks to bring spectrum abundance for emergent space activities. “Emergent” or “emergent space operations” are those spacecraft or commercial operations in space that use radio spectrum for control of, or communications with, a spacecraft, but which are not communications satellites. Currently there is an acute shortage of usable and readily accessible spectrum for telemetry, tracking and command (TT&C) functions that are essential for operating emergent spacecraft. Accordingly, the NPRM seeks to clarify and expand the Commission’s traditional regulatory classifications so that emergent space operations have more predictable access to spectrum. Additionally, the NPRM proposes to add a secondary allocation for the Space Operation Service (SOS) in spectrum bands that could support emergent space activities, particularly in frequency bands allocated for non-Federal use that may be lightly used in certain geographic areas. The NPRM also proposes to allow existing licensees to lease their spectrum to earth station licensees to provide SOS in connection with emergent spacecraft.

What the Notice of Proposed Rulemaking Would Do:

- Seek comment on how to provide regulatory clarity and to leverage existing spectrum allocation to support emergent space operations.
- Seek comment on codifying the use of frequency “piggybacking.”
- Seek comment on permitting TT&C operations in FSS bands where TT&C may already be provided within the radiocommunication service.
- Seek comment on a potential interpretation of TT&C definitions.
- Propose to add an allocation for SOS (Earth-to-space) in the 2320-2345 MHz band and permit a version of *de facto* spectrum leasing in that band to earth station licensees and ask whether

to extend this proposed framework to nearby bands, such as the 2305-2315 MHz and 2350-2360 MHz bands.

- Seek comment on whether other satellite operators should be authorized by rule to use their FCC-licensed satellites and intersatellite links to provide TT&C and data downlinks to emergent spacecraft.

This constant jockeying for dedicated spectrum allocations for space use reminds me of the era before the consolidation of many disparate portions of spectrum allocations rolled up into national mobile networks. One approach to meet the need for “launch communications” that seems more reasonable to me is the creation of a network of satellites specifically for spaceflight support. “Weird Space Stuff” could use such a satellite network at lower cost and much less effort (and expense, and complexity) than trying to establish unique spectrum, unique network of ground stations, etc.

NASA pioneered this approach with its Tracking and Data Relay Satellites (TDRS) system. More recently, SpaceX has demonstrated the feasibility of this idea with various SpaceX launches downlinking video and telemetry via Starlink satellites. Maybe Amazon with its history of building “sold as a service” infrastructure might consider providing such services with their nascent [Leo service](#) that’s currently being built.

Another potential solution to this issue is to begin using “[cognitive radios](#)” in such circumstances that can detect moment by moment usage of existing portions of spectrum and “identify, use, and vacate” for each transmission. Honestly, the unique capability of ka9q-radio to “listen to all channels, simultaneously” is an absolute game changer for radio communications. You no longer have to allocate unique portions of spectrum to dedicated tasks “so you know where to listen”. If “Weird Space Stuff Launch 7825” needs to transmit telemetry, it identifies a portion of spectrum that seems clear for a data burst and transmits it. The ground station, being able to “receive every channel” is monitoring every potential portion of spectrum for a telemetry transmission, and thus receives the telemetry transmission of “Weird Space Stuff Launch 7825” with no issue.

[ARDC is Hiring: Software Developer \(PT Contract\)](#)

***Editor’s Note** - I ran this item several weeks ago and I was asked by ARDC to run it again. I’m happy to oblige!*

ARDC seeks a mid-to-senior-level Software Developer to work with our staff on a contract basis. The role will support ongoing development of our 44Net program services, and potentially other related Free Software projects. An ideal candidate will be active in Free and Open technology communities – particularly those related to amateur radio, digital communications science, F/OSS development, and DIY culture.

[ARDC is Hiring: Technical Writer \(PT Contract\)](#):

ARDC seeks a Technical Writer to work with our staff on a contract basis. The role will support ongoing development of our 44Net program, and potentially other technical publishing activities. An ideal candidate will be active in Free and Open technology communities – particularly those related to amateur radio, digital communications science, F/OSS development, and DIY culture.

I’ve been involved previously, and currently, as a volunteer for ARDC. In my experience, they’re good folks to work with, and for, doing important and relevant work in Amateur Radio and adjacent areas such as open source development.

Thus I endorse and recommend these positions and ARDC as a whole.

[Tuscon Amateur Packet Radio TNC Radionics Micro Processor RARE!](#)

Ebay listing:

The Tuscon Amateur Radio TNC Radionics Micro Processor is a rare and unique item for ham radio enthusiasts. This micro processor is designed to enhance the performance of ham radio receivers, allowing users to achieve more precise and reliable communication. With its advanced technology and specialized functions, this TNC Radionics Micro Processor is a valuable addition to any amateur radio setup, offering improved signal stability and clarity for a superior listening experience.

Buy it now: \$250

This unit is a TAPR Terminal Node Controller (TNC) - later renamed the TNC-1.

Superior listening experience... 😞 Can't make this stuff up.

*Please direct comments / feedback about **ZR > BEACON** to the [Zero Retries email list with the #ZR0247 hashtag](#).*

Request To Send

By Steve Stroh N8GNJ

Editorial, Commentary, and Occasional Digressions

Pressures of a Weekly Newsletter

One (of many) limitations of Zero Retries as a weekly newsletter, is that there are weeks that timeliness trumps completeness. In this case, my being a part time writer / Editor (with other things competing for my time during the week), and the desire to get the two stories in this issue published while they're still timely, conflicts with doing a more complete treatment the subjects of those stories. Ideally I could have (and, arguably, should have) contacted Billy Penley KN4MKB and Nino Carrillo KK4HEJ for their direct perspectives on the stories I wrote in this issue of Zero Retries about their projects.

Thus, sometimes I envy the longer development / editing / production cycle of a magazine format with much longer lead times.

But in the end, I felt that Zero Retries readers were better served by discussing these two developments, in a timely manner, from my perspective. KN4MKB laid out his position very well on his blog, and KK4HEJ has chosen, to date, not to mention anything about his project beyond the brief mention on Discord.

Both of these projects will be much more widely exposed in the months to come so they'll get ample publicity. Thus I view Zero Retries role, at this stage, is to make more people aware of the exciting potential of these two projects, and the changes they presage in Amateur Radio data communications... and their contributions to Technological Innovation in Amateur Radio.

Focus is the Tradeoff For Keeping Up With Technological Innovation in Amateur Radio

There's an old (*old*) [joke](#):

A pedestrian on 57th Street sees a musician getting out of a cab and asks, "How do you get to Carnegie Hall?" Without pause, the artist replies wearily, "**Practice.**"

So how does one keep up with the amazing, seemingly more, and more interesting, *by the month* firehose of technological innovation in Amateur Radio?

This Editor replies, wearily, “**Focus**”.

Really! *No one has the bandwidth* to keep up with literally hundreds of Amateur Radio (and adjacent fields) innovators that are pushing out technological innovations by the month. I certainly don't⁷. It's not your imagination. The more technological innovation I find and try to feature here in Zero Retries ... **the more I find**. The discovery of one technological innovation leads to another. It never ends. It's a (joyful, and endlessly fascinating) positive feedback loop.

The only way I know of to truly keep up with technological innovation in Amateur Radio is to restrict one's focus to what *you're* most interested in and what *you're* most passionate about.

My favorite example of such focus is the (Digital) Amateur Television folks. Despite that their preferred mode is fundamentally a stream of digital bits, to them, DATV is about *realtime image communications*. The digital / data aspect of Digital Amateur Television (DATV) is entirely secondary to them having fun with building equipment for and communicating with their buddies with *realtime image communications via Amateur Radio*. That they could be accomplishing the same thing, perhaps more flexibly, perhaps in a more modern context, by videoconferencing over a data network via Amateur Radio (like AREDN) isn't of interest to them. They like **DATV**, not data communications. Thus to keep having fun, the DATV folks exercise an admirable focus on their preferred mode, paying attention to the innovations that occur in relation to DATV - new equipment, new techniques, etc.

If you're interested in Amateur Television, the best way to keep up to date is to request to be added to the **great** Amateur Television Journal newsletter edited by Jim Andrews KH6HTV: <https://kh6htv.com/newsletter/>. You might think that it's a “local” newsletter, and it covers the activity in the Boulder, Colorado area well, but it also reports on many other areas, including some international activity. *Highly recommended!*

That... and if there's something interesting happening that you're a fan of, like DATV, and there's a group *doing* the fun things like DATV that you enjoy hearing about and want to enjoy too, find a way to help support them with participation, encouragement, spreading the word, and perhaps financial support.

Hamvention Ho!

**4 weeks until [Hamvention 2026](#)
in Xenia, Ohio, USA...
Zero Retries / DLARC booth 1506
in Building 1 / Maxim**

Weekends Are For Amateur Radio!

The priority this weekend for me is to dust off some vintage TNCs out of the collection(s) of N8GNJ / Zero Retries Labs for a promised demonstration of vintage (but recent memory, to me) Amateur Radio Packet Radio data communications.

And I really have to get that MeshCore node on the air!

Have a great weekend, all of you co-conspirators in Zero Retries Interesting Amateur Radio activities!

*Please direct comments / feedback about **Request To Send** to the [Zero Retries email list with the #ZR0247 hashtag](#).*

73,

Steve N8GNJ

Closing Thanks

My ongoing **Thanks** to:

Tina Stroh KD7WSF for, well, *everything!*

Jack Stroh, Late Night Assistant Editor Emeritus

Fiona and Shrekky Stroh, Late Night Assistant Editors In Training

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Founding Member 0024 - Rob Bowser (SPOOLTENNA) (New 2026)

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You thousands of readers of Zero Retries without which there would be little point in publishing this newsletter.

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This issue, **Zero Retries 0247**, was published on 2026-04-17. This issue was 9296 words.

(end)

Footnotes For This Issue

To see the relevant sentence for the footnote, just click the footnote number.

[1](#)

This reference isn't correct. I met Ray Petit W7GHM who stated that he was the inventor of CLOVER. [Additional reference](#).

[2](#)

No explanation provided for the context of this page (or that section, listing a very incomplete list of data modes used on Amateur Radio spectrum).

[3](#)

VARA FM and VARA HF require license key (fee is \$69) which provides full functionality (full speed tiers).

[4](#)

Audio OFDM is OFDM technology applied to the audio bandwidth of a conventional radio.

[5](#)

In Amateur Radio, *broadcasting is prohibited*, but *transmission of "bulletins"* is encouraged. Thus we try not to say the "B" word.

[6](#)

Apparently Othernet is now out of business. Bummer.

[7](#)

One of the sadder realizations with Zero Retries is that *I can't do it all*. I can't keep writing Zero Retries on a weekly basis, at a level of quality and quantity that I can feel proud of... and be able to spend entire weekends and evenings noodling around in N8GNJ / Zero Retries Labs. Something has to give, and for the moment, that's the latter in favor of the former. That's a conscious choice.